ExLog Distribution
Notional Employment Scenario for Future Technology Insertion

Introduction: This document outlines at sea cargo transfer, handling, and projection capabilities that are being developed by the Expeditionary Logistics (ExLog) Program of the Office of Naval Research. The thrust of the document is to identify the need for these capabilities, identify the capabilities, and show how technology developed by the ONR ExLog program will support future Navy and Marine Corps operations.

The focus of work outlined in this document is in support of the Sea Base pillar as outlined in Naval Power 21; however, it should be clear that the capabilities outlined in this CONOPS are critical to the feasibility of the other 2 pillars of Naval Power 21, Sea Strike and Sea Shield. The ability to refuel, replenish, re-arm, and power on is critical to Sea Shield and Sea Strike; consequently, development of cargo transfer and related at-sea material movement technologies and capabilities are absolutely essential to the successful implementation of every aspect of Naval Power 21.

Background: The U.S. Navy and Marine Corps are transforming to better support the revolution in military affairs that is driven by new technological capabilities and changed military/geo-political requirements. The scope and structure of the required transformed capabilities are outlined in Naval Power 21. Naval Power 21 is organized around 3 pillars: Sea Shield, Sea Strike, and Sea Basing; each of these pillars entail enhanced operations at-sea and will require substantially enhanced logistic support at-sea. Because the focus of most at-sea logistic cargo transfers will be the sea base, this CONOPS is structured around the sea base; however, the extensions to Sea Strike and Sea Shield should be apparent.

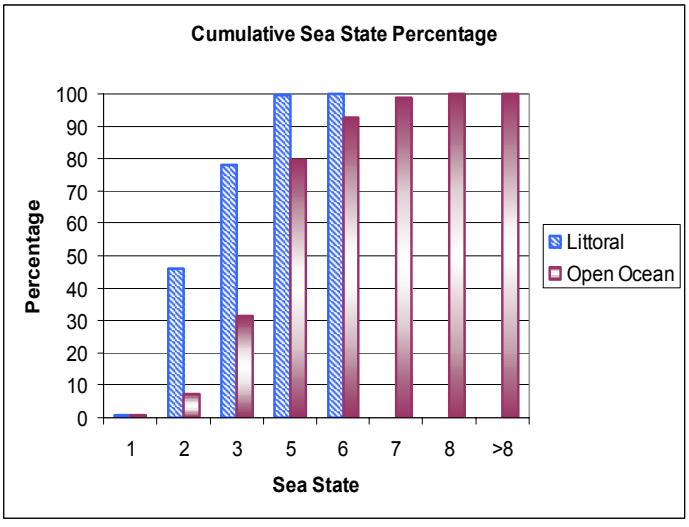
The Navy and Marine Corps have supported sea based expeditionary warfare “from the beginning”. The Marine hymn memorializes one very early action on the shores of Tripoli. Sea based expeditionary warfare is not “new”, what is new is the scope and nature of future sea based operations envisaged in Naval Power 21. The new Sea Base will have the capability to support large warfighting operations, and also support indefinite sustainment with a relatively small number of ships. These new characteristics require that the new sea base be able to transfer personnel, fuel, and cargo at-sea from supply ships of all types, explicitly including commercial vessels, to naval combatants of all types, explicitly including small lighterage that may be used to carry supplies to shore in support of Marine Corps expeditionary operations.

Sea base requirements to support Marine Corps expeditionary operations are still under development so that a definitive breakdown of supplies needed to support operations from the future sea base does not exist. An initial draft of the sea basing CONOPS states that a Marine Expeditionary Brigade will require nominally 1,500 tons of packaged cargo per day. Additionally, the sea base itself will support a Marine Corps headquarters detachment of 500 people, and combat support personnel and facilities that will support any Marine Corps deployment. The staff and combat support people

and facilities will require additional replenishment and support at sea, whereas they are currently supported with supplies and material that are transported to ports and delivered to ground facilities. Finally, the sea base itself, and supporting vessels, will need additional replenishment, delivered on station at sea, to support the enhanced scope of sea based operations. The current draft of the sea basing CONOPS states that the Sea base will receive 2,000 tons of packaged cargo per day.

All of the other supplies, material, and personnel listed above must be brought to the sea base and most importantly, transferred to the ships of the sea base. Carrying large quantities of supplies on a ship from a port is not a technological challenge. Accessing specific components and containers at sea, and transferring those supplies from one ship to another at sea is a challenge and is the focus of the ExLog technology development efforts.

In addition to the large amount of supplies needed to support future sea based operations, the nature of logistics support that is required will change. Today's amphibious operations focus on assaults over the shore and into seaports in order to establish footholds ashore that permit the buildup of sufficient combat power to conduct operations against inland objectives. This older CONOPS requires an operational pause for resupply and reorganization, thereby losing momentum through a decrease in operational tempo. Operations from a future sea base focus on direct assault on inland objectives with no operational pause. After the initial objectives are achieved some or all of the force can be recovered to the sea base, reconstituted, maneuvered within the sea base, and rapidly deployed elsewhere. This rapid and flexible manner of conducting operations will not be possible if forces are tied to a large land-based logistics footprint. Individual warfighting units will require logistic support directly from the sea base, and they will only be resupplied with the specific items that the unit requires. This shift in tactics will be made possible by the enhanced logistics support capabilities of the sea base. The sea base will be able to transfer material as needed among ships comprising the base and to the ground fight as required. This enhanced level of support requires an ability to conduct material transfer operations under the adverse sea conditions likely to be found in the area of operations. Future sea basing concepts require the sea base to be more than 25 miles out to sea. Current at-sea cargo handling systems are limited to sea state 2 operations. This is acceptable in the littoral environment within a few miles of the shore but as the seabase moves out to the open ocean environment of 25 miles offshore, the probability of encountering higher sea states increases. The chart shows the differences in the cumulative



probability of encountering seas in the littoral and open ocean environments. As the sea base moves offshore, the probability of encounter for sea state 2 or lower can be less than 10% of the time. This will require that future cargo handling and transfer systems be far more robust than current systems in terms of their sea states of operation.

Another logistics aspect associated with sea base operations 25 nmi, or more, off shore is the need to provide fast and responsive surface craft to move logistics supplies ashore. Large sea base stand-off distances entail long transit times, which fundamentally slow the supply system and make it less responsive. Means are needed to move supplies quickly from the sea base to the shore, and in some cases hundreds of mile inland to support the ground fight.

Finally, to support the increased logistics burden, the sea base must interface with a wide range of Navy and commercial vessels. Technology must be developed to support transfer of 20 foot ISO containers in adverse conditions. Break bulk and selective off-load technologies must be developed to quickly support resupply to naval and ground combatants.

These future sea basing concepts are beyond the current operating capabilities of today's fleet. Therefore, technology development and insertion will be required in order to meet future doctrine. The ExLog FNC Distribution Enabling Capability will address many of these issues with technology development. The HiCASS product line will enable commercial ships to provide resupply of the sea base directly from CONUS and will enable faster resupply of the sea base, including the carrier battle group. Once the cargo is on board, the Strike-Up/Strike-Down product line will address movement and selective offload within the seabase ships in order to provide tailored packages to address warfighter needs. The Naval Force Sustainment product line will enable new connector technologies and provide more efficient packaging to support the rapid tempo of at-sea arrival and assembly operations. The Sea base to Shore Surface Craft product line will address the high-speed, high-capacity transport of troops and supplies ashore from the sea base.

High Capacity Alongside Seabase Sustainment (HiCASS)

Supplies and material will originate from CONUS or advanced support bases. The rapid tempo of future ship to objective maneuver operations will require the transfer of a tremendous amount of sustainment cargo into the seabase. The ability to handle heavy inter-modal packages such as 20 foot ISO containers, which can easily move through distribution chains from CONUS to the sea base must be developed. Provisioning and loading of the ships used to supply materials to the sea base are outside the scope of the HiCASS program; however, outfitting those ships with equipment needed to support cargo transfers may be within the scope of the HiCASS program.

When ships arrive at a sea base they may transfer their cargos using VertRep, STREAM, or other CONREP technologies. To achieve the cargo transfer rates required to support robust (i.e. all weather) sea base operations, it is envisaged that vessels may come alongside and transfer their loads with either cranes or on ramps provided by the Navy sea base logistic support ship (e.g. the MPF.). Transfer of 20 foot ISO containers with weights to 53,000 lbs is envisaged. This level of connectedness is currently beyond Navy operations as are at-sea cargo transfers of the magnitude required. Container ships are generally unloaded in port by large gantry cranes that move the loads from the ship to the shore; the ships do not typically have organic self unload capability. To the maximum extent practicable, the replenishment ships will not require outfitting or special rigging of any sort. The sea base will require that these containers be unloaded at-sea, in the sea conditions of the open ocean at the location of the operation. Some of the technical issues to be addressed by HiCASS include enhancements in the following technologies:

- *Real-time tracking/sensing of own ship/platform motions and those of the other ship/platform involved in the at-sea material transfer*
- *Relative Motion Mitigation or Compensation*
- *Sensing of wave environment to enable predictive control*
- *Motion compensating transfer systems capable of the precision required*
- *Dynamic Positioning of Vessels in a Sea Way to enable Station Keeping*
- *Tension Sensing*
- *Situational Awareness*
- *Distance Sensing*
- *Load Position/ Dynamics Sensing*
- *Positive Load Control*
- *Autonomous Connection Technologies*
- *Energy Storage*

Shipboard Internal Strike-Up/Strike-Down (SUSD)

Once cargo and weapons have been taken aboard the ship they will have to be handled within the ship to their stowage locations. Future warfighting concepts envision a very small logistic footprint ashore in order to meet the flexibility and maneuverability requirements. Material required by tactical units ashore will have to be identified and accessed from the stores afloat and assembled in to packages tailored for each unit. The logistics model is a just-in-time delivery system. This requires a robust selective offload capacity that allows the ships to be automated warehouses which can provide the exact loads that the expeditionary fighter requires at a rapid tempo. Loads the size

of current pallets will likely be the largest load to be provided to the warfighter in order to prevent additional handling and distribution within the field. Advanced cargo handling and movement systems are required to retrieve the required items from the selective offload systems and tailor packages for delivery. These tailored packages will then be moved within the ships to the air or surface delivery point. New technologies are required in order to meet the speed required of future operational tempos as well as to reduce the amount of crew workload required to move the cargo into and out of stowage and to meet the rates of delivery onto the ship via HiCASS. Some of the technical issues to be addressed in this product line are:

- *Non-linear actuator drive systems and controls*
- *Linear induction motors*
- *High-strength materials*
- *Human amplification technology*
- *Ship motion compensation for force control based systems*
- *Automated vehicle guidance and control systems*
- *Intelligent systems*
- *Robotics*

Naval Force Sustainment (NFS)

One aspect of sea basing will contain ships operating in support of each other within the same area of operations (AO). The movement of personnel and equipment will occur from ship-to-ship and from ship-to-shore in the sea states encountered within the sea base AO. With the operational tempo being extremely high, connector assets that are fast, simple, and flexible will be used to enhance the operational reach of maneuver units over extended distances and deliver in-stride sustainment to the war fighter much faster. Moreover, new technologies that will enable general cargo transfer techniques, weapons transfer, and packaging of configured loads and sensitive cargo will be required to make this possible. Technical issues that may be addressed in this product line include:

- *Energy production/energy storage/power generation*
- *Advanced materials/Blast Resistant Materials*

- *Connectors*

Sea Base to Shore Surface Craft

As the sea base moves further offshore the surface craft used to transfer personnel, cargo, and vehicles will have to become more robust. Higher speeds and greater lift capacities will be required to offset increased standoff distances and increased operational tempo. Future heavy airlift will not be able to deliver heavy vehicles such as main battle tanks, therefore these will require surface transport. Operational flexibility requires that the cargo and vehicles be able to operate in a wide variety of austere conditions, such as beaches, so that shallow draft or hover ability will be necessary. New technologies required to support the required increase in capabilities might include:

- *Advanced Craft Propulsors*
- *High Capacity/High Speed Beachable Lighters*